IN SENATE OF THE UNITED STATES.

JULY 3, 1838.

Submitted, and ordered to be printed, and that 5,000 additional copies be furnished for the use of the Senate.

Mr. TALLMADGE submitted the following

REPORT:

The Committee on Naval Affairs, to whom was referred the memorial of Henry Hall Sherwood, of the city and State of New York, claiming to have made new and important discoveries in magnetism generally, and more particularly in the magnetism of the earth; and representing that he is the inventor of an instrument called the Geometer, whereby, without the aid of the quadrant, or sextant, or chronometer, and without taking a celestial observation, it is practicable and easy, at sea and on land, and in all weathers, to determine, merely by the dip of the needle, the variation of the needle, and the latitude and longitude of any place on the surface of the globe; and praying the aid of Congress to enable him to proceed with the publication of a work explaining these discoveries, and the uses of that instrument, and to commence the manufacture of the same in the most perfect manner, report:

That, from the late period in the session when this memorial was referred to the committee, they have been unable to give to the subject that thorough examination and investigation which, under other circumstances, they would have been pleased to give. They have, however, availed themselves of the opinions of scientific gentlemen, who have had a better opportunity to examine it, than the limited time of the committee has permitted to them. These opinions are annexed to, and are intended to form a part of, this report. From these opinions, as well as from their own examination, the committee are fully persuaded that the discoveries and invention of Dr. Sherwood are entitled to the most serious consideration of the public, and to the encouragement and patronage of Congress. The committee regard them as highly interesting and important to the navigation and commerce of the United States, and as bidding fair to open a new era in the history of the science of magnetism. They refer to the communication of Dr. Dwight, as containing a full and ample view of the discoveries of Dr. Sherwood, and to those of other scientific gentlemen and officers of the navy, as to the principles and practical operation of the GEOMETER.

The committee find that heretofore Congress has made a distinction between those inventions which have been of private utility merely, and those which are directly important and advantageous to the Government.

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Whilst the former have been left to individual encouragement, the latter have received Governmental patronage. If the expectations of those, who have most fully examined and investigated the discoveries and invention of Dr. Sherwood, are to be realized, the committee are fully of opinion, that in this respect, they stand on very high ground; and that the invention must prove of immense importance to the Government and people of the United States, and to the civilized world.

The committee are unable, from their own knowledge, to pronounce an opinion as to the extent of these discoveries, and of the practical operation of the geometer in all cases; but they have seen and examined the subject sufficiently to satisfy them that the efforts of Dr. Sherwood to advance the cause of science, and to confer such immense benefits upon mankind, as a successful result of his experiments would do, entitle him to the liberal patronage of Congress.

Doctor Sherwood, as the committee understand, has in preparation a quarto volume, which is to comprise the elaborate tables, upon which the practical rules of the geometer are based, and numerous plates illustrative of the principles of the science, and the uses of the instrument, together with a history of his discoveries and invention. He is also desirous of perfecting the geometer, by the aid of the most skilful mechanical talent and experience in its construction. For that purpose he deems it important, without delay, to proceed to England, where he can best avail himself of that talent and experience, and where he can, also, at the same time, best carry out the design of his publication. The committee are aware that this cannot be done without considerable expense—an expense far beyond the pecuniary ability of Dr. Sherwood to incur. They deem the subject of so much importance, that they do not hesitate to express the opinion that an enlightened policy on the part of the Government should induce Congress to grant the requisite aid. By such aid, and by such aid alone, a discovery and an invention which may prove so important to science, and so useful to mankind, may be perfected, and confer lasting honor on him, who has already devoted to the subject the best portion of his life, as well as enduring fame upon the country.

The committee will, as soon as they are able, present, for the consideration of the Senate, such a bill as shall be best calculated, in their judgment, to carry out the recommendations of this report.

WASHINGTON, *June* 26, 1838.

SIR: The petition of Dr. Henry Hall Sherwood, of which I send you a copy, has been referred by the Senate to the Committee on Naval Affairs. I have been instructed by that committee to make such inquiries of scientific gentlemen as shall be best calculated to throw light on the subject of the memorial.

Understanding that you have devoted much time and attention to Dr. Sherwood's discoveries and inventions, I respectfully request, on behalf of the committee, that you will furnish me, in writing, a full statement of facts, on the subject of his discoveries in magnetism generally, and more particularly in the magnetism of the earth, and of the instrument invented by him, called the geometer; including such a view of the history and present

state of that science as may present the discoveries of Dr. Sherwood in a proper light; together with an opinion as to the practicability of determining the latitude and longitude, both by land and sea, by means of the geometer.

Very respectfully,
Your obedient servant,
N. P. TALLMADGE.

Dr. DWIGHT.

WASHINGTON CITY, *June* 28, 1838.

SIR: On the memorial of Dr. Henry Hall Sherwood, of the city of New York, relating to discoveries made by him in the science of terrestrial magnetism, and to an instrument called the GEOMETER, which he has invented for determining the latitude and the longitude, which memorial is now waiting the action of both Houses of Congress, you have requested me to draw up, for the Committee on Naval Affairs, a full statement of the facts, within my knowledge, relating to the subject; as well as an expression of my own opinion as to the practicability of determining the latitude and longitude, both by land and sea, by means of the geometer. In complying with this request, I have prepared the following statement:

The memorialist is a native of Williamstown, Massachusetts, and went with his parents, in childhood, to the State of New York. Through the kindness of an uncle, he received an *academial* education, and subsequently a regular education to the medical profession, which he has pursued as the means of his support.

About twenty-five years since, his attention was turned to the science of magnetism; and a short course of experiments satisfied him that many of the statements in the books relative to it were erroneous; that many of its important principles and laws were unknown; and that the facts actually known, were stated, in the best treatises, with so little regard to principle and arrangement, that magnetism scarcely deserved the name of a science. From the discoveries which he made, taken in connexion with the figure of the earth, and the circles described on its surface, he became early and immoveably convinced that an instrument might be devised, by the aid of which the latitude and the longitude of every place on the surface of the earth, might be determined. This conviction, and the immense importance of the subject, led him to devote all the time and effort, not necessary for the support of his family, to the prosecution of these discoveries, and to the completion of the devised instrument. This, rather than his profession, he has made, for many years, the commanding business of life; and with what success may be learned from a simple detail of facts.

Before proceeding to this detail, however, it is proper here to introduce a very brief sketch of the history of previous discoveries in the science of magnetism, in order to show its connexion with many of the important interests of mankind. For this, I acknowledge my obligations to the able work of Dr. Barlow, on electro-magnetism.

The earliest mention of the *loadstone* is in the writings of *Homer;* in whose time its *attractive* power appears to have been familiarly known. It is also mentioned by *Pythagoras, Plato, Aristotle,* and *Euripides,* as well as

by *Pliny*. *Plato* also knew its *communicative* power, and, of course, was somewhat acquainted with *artificial magnets;* for he has described a chain of iron rings suspended by one another, the first being sustained by the loadstone. But the most important property of the magnet, that of *direction*, or *polarity*, was not known in Europe until long after the commencement of the Christian era.

It is difficult to decide *when*, and *by whom*, the *polarity of the needle* was first discovered. The Chinese attribute the discovery to the Emperor *Tchi- Yeou*, in the year 1040, B. C.; but the validity of the claim is generally regarded as doubtful. *Are Fronde*, an Icelandic historian, born A. D. 1068, and who probably wrote before 1100, mentions the *directive* property of the loadstone as customarily known by the northern seamen; but does not intimate that the *form of the compass* had been suggested. The *mariner's compass* is described in *La Bible Guiot*, a poem of *Claude Fauchet*, who was at the court of the Emperor Frederick Barbarossa, at Mentz, in 1181. *Paulus Venetus* is said to have brought the invention to Italy, in 1260; having learned it of the Chinese. *Peter Adsiger*, in a Latin letter dated in 1269, and preserved among the manuscripts of the University of Leyden, describes minutely the mariner's compass, and mentions the *variation of the needle*. *Columbus* also discovered it from observation, on his first voyage, September 14th, 1492; and the discovery, by the alarm which it excited among his men, came near to defeating his important enterprise. *Robert Normand*, a mathematical instrument-maker, in London, discovered the *dip of the needle* in 1576. He states it at that time to be 71° 50′. The earliest accurate observation of the variation of the needle was made by *Borough*, at Limehouse, in 1580. He states it at 11° 15′. The earliest *variation charts* were published by Prince *Maurice, of Nassau*, Lord High Admiral of Holland, in 1599. *Gellibrand*, in 1633, discovered that the variation of the needle is not *uniform*, but is subject to an annual increase or decrease. In 1600, Dr. *Gilbert* advanced the first theory to explain the phenomena of magnetism. He insists that the *land* is magnetic, and that the *sea* is not; and that hence the needle always turns from the sea to the land. In 1683, the Government of William & Mary, with an enlarged and honorable liberality, intrusted one of the ships of war to the direction of that eminent philosopher and astronomer, Dr. *Edward Halley*, with orders "to seek, by observation, the discovery of the rule for the variation of the compass." He made repeated voyages, traversed portions of the Atlantic and Pacific oceans, and formed a very accurate and valuable *Chart of the Variation*, which was published in 1701. Soon after he published a very ingenious Theory of Terrestrial Magnetism, in which he supposes that the earth has *four magnetic poles*, two northern, and two southern; one about 7° from the north pole, and near the longitude of the Land's End; a second, about 15° from the north pole, and on the meridian of California; a third, about 16° from the south pole, and about 95° west from London; and a fourth, about twenty degrees from the south pole, and about 120° east from London. Two of these he represents as *fixed*, and two as *revolving* with a very slow motion. *Euler* advanced the theory that there are but *two* magnetic poles. *Hanstein* insists that there are *three*. In the present century, *M. Biot* and Professor *Kraft* have maintained that the two magnetic poles are indefinitely near to each other, near the centre of the earth.

Before closing this brief sketch of the history of magnetical discoveries, it is proper to remark, that the phenomena of the compass and the dipping needle have now, for nearly three centuries, fixed the interested attention of the philosophers of Europe; and that several of the European Governments, and above all that of Great Britain, have aided the researches in this interesting science by a liberal patronage. As an illustration of this last remark, it may be observed that the Board of Longitude in London, for a series of years, offered a reward of £20,000 sterling to the individual who should discover a method of determining the longitude; that the sum of £10,000 sterling is said to have been awarded to the instrument-maker who furnished the best chronometer on the Arctic voyage of Captain Parry—an instrument so perfect, that, amid all the changes of climate, it varied only 8 seconds in three years; that the sum of £8,000 sterling is understood to have been since offered to any individual who should discover a method by which this instrument may be employed at sea, in exactly determining the longitude; and that £5,000 was awarded to Captain Ross, for his supposed discovery of the north magnetic pole. It ought here to be added, that the British Government has just erected a noble MAGNETIC OBSERVATORY at Greenwich, with an apparatus of the best instruments, in which a course of observations of the absolute variation of the needle is to be made twice each day, in order to ascertain the rate of its progress, and the laws by which it is governed; that a similar institution is now in progress at Dublin; and that another has been for some time in operation at Göttingen. This policy is eminently wise; since a knowledge of the laws, which regulate the motions of the horizontal and dipping needles, is connected, not only with the advancement of science, but with many of the most important interests of mankind.

In recurring to the investigations of Dr. Sherwood, it may be proper to mention, in the first place, those discoveries which relate to the laws of magnetic influence, and subsequently those which relate to the magnetism of the earth; and then to point out the nature and use of the geometer, the instrument which furnishes the practical application of these discoveries.

In speaking of the discoveries which relate to the laws of magnetic influence, with the exception of the *formation* of the magnets by Dr. Sherwood, I speak of *facts*, witnessed not only by myself, but by very many members of both Houses of Congress, as well as by many scientific gentlemen in this city.

Dr. Sherwood has succeeded in magnetizing a *continuous iron ring*, and a *circular iron plate;* which has heretofore been regarded as impracticable. In proof of this last position, I quote the following extract from the treatise of Dr. Roget, of London, (p. 90,) in the Library of Useful Knowledge, published in London, in 1832:

"If a steel bar, instead of being bent into the form of a horse-shoe, be formed into a complete ring, and then magnetized, it exhibits no magnetic properties, as long as the ring is entire; but, when broken into any number of portions, each part has two poles, and possesses all the properties of an ordinary magnet. A ring so constituted, or an *electro-dynamic ring*, as it has been called, is found to exert no action upon a voltaic conductor or magnet, at whatever distance from it, or in whatever situation it may be placed."

The failure to magnetize a ring, or a circular plate of iron, arose probably from a mistake in the mode of attempting it. If the ring or plate is

moved all round on one of the poles of a horse-shoe magnet, and then on the other, it exhibits no magnetic properties. Dr. S. selected two opposite points in the circumference of the ring or plate, 180° apart, which may be called the *poles of the ring* or *plate*, and connected them by a straight line, which may be called the *polar axis of the ring* or *plate*. Taking the plate* in both hands, at the two points 90° from the two poles of the plate, or at its *equator*, he turned the circular plate half round one way, and then back again, on one pole of a horse shoe magnet; and then drew it towards him over the same pole, keeping the polar axis of the plate over the middle of the pole in its passage. Then, reversing the plate, he treated the other half of the plate in the same manner. He found that the plate had two magnetic poles, 180° apart, connected by a magnetic axis; as well as a magnetic equator, 90° from the magnetic poles, and at right angles to the magnetic axis. It proved, however, that the *magnetic poles* were not in the same points with the *poles of the plate*, nor *in the polar axis*. On the contrary, the magnetic poles were both in a diameter of the plate, drawn at an angle of 23° 28′ from the polar axis: one of them on the left of one pole of the plate, and a second on the right of the other pole, and 180° apart; but on drawing a diameter on the other side of the axis, at the same angle, it was found to have no polarity at either end. The magnetic equator and the equator of the plate of course stood at the same angle as the two axes, *i. e.*, at an angle of 23° 28′.

On applying the *compass* to either magnetic pole, the dissimilar pole of the needle pointed to it, and its axis was in a line with the magnetic axis. On moving the compass round the circumference of the plate, the needle *declined* towards the near magnetic pole, at an angle proportioned to its distance. At the magnetic equator, the needle lay parallel, not with the magnetic axis, but with the polar axis, or axis of the plate. On moving the needle from one end of the magnetic equator to the other, the needle was every where parallel with the polar axis. On either side of the magnetic equator, within the plate, one pole of the needle was drawn towards the nearer magnetic pole, or had every where a *variation*. On passing the needle from one magnetic pole to the other, its axis was in the line of the magnetic axis, and its poles pointed each to the dissimilar magnetic pole.

On applying the *dipping needle* to the circumference of the plate, at the magnetic poles, the needle was not perpendicular, as it would have been, if the poles had been at the edge of the plate, but inclining to a point within the plate; and, on moving the needle to a point a small distance within the plate, along the magnetic axis, the needle immediately became perpendicular. *This point* is the true magnetic pole. In moving the needle from this point towards the other magnetic pole, it *dipped* towards the nearer pole, at an angle equal to its distance from the magnetic equator, or to the *magnetic latitude*. On the magnetic equator, the dip vanished, and the needle became horizontal. The same was true, *mutatis mutandis*, on the other side of the magnetic equator. On passing the needle from one end of the magnetic equator to the other, it was every where on a horizontal level. On every point on each side of the magnetic equator, the dip was uniformly equal to the *magnetic latitude*, or to the distance from the magnetic equator, measured on a magnetic meridian.

* Henceforward, to avoid a disagreeable repetition, I use the word *plate*, instead of the phrase *ring or plate*.

Doctor Sherwood then magnetized a large circular plate of fourteen inches diameter, having, however, a small circular perforation in the centre, but in a different manner. Having marked a polar axis as before, he laid it on the south pole of a horse shoe magnet, and then drew it towards him over the pole, in the line of the polar axis. The results were equally singular. This magnet had *three* magnetic poles: a south pole in the polar axis, near one extremity, and two north poles, each 23° 28′ on each side of the other extremity, or 46° 56′ apart. These were at points equallly distant from the edge, within the circumference, and the south pole was double that distance within it. Three magnetic radii, or *semi-axes*, met in the centre, forming a Y; the angle of the upper part of which, or of the two north semi-axes, was 46° 56′. The magnetic equator consisted of two radii, equidistant from the south semi-axis, and much nearer to it than to the two north semi-axes. The reason of this is not known.

On applying the *compass* to the end of the polar axis, half way between the two north poles, the needle lay in the line of that axis; but, on moving it, in the least, towards the right or left, it turned instantly towards the nearer north pole. If the two north semi-axes are extended from the centre to the opposite points of the circumference, on the right and left of the south pole, and the compass was laid on either of the two radii thus drawn, the needle made a right angle with it. If placed at the centre, it made a right angle with the polar axis. If laid on either of the north semi axes, however small the distance beyond the centre, it instantly turned and pointed to the nearest north pole in the line of the semi-axis. If on either side of the north semi-axes, and north of the equator, it declined towards the nearest north pole If on either radius of the magnetic equator, it was parallel with the polar axis. If between the equator and the south semi-axis, it declined towards the south pole. If on the south semi-axis, it lay in the line of that axis.

On each radius of the magnetic equator, the *dipping needle* was horizontal, as well as at the centre where they meet. On each magnetic semi-axis, it dipped towards the nearest pole.

Dr. Sherwood also magnetized two thin, rectangular, oblong, iron plates; one in the common way, the other, by simply laying it on the south pole of a horse-shoe magnet. The first became a common magnet, with a north and south pole: one on the left, and the other on the right, of the polar axis, or axis of the plate, and apparently at an angle of 23° 28′. The two poles were here, also, within the edge of the plate. The magnetic equator, also, made an angle of about 23° 28′ with the equator of the plate. On every part of the magnetic equator, the needle was parallel to the polar axis, and the dipping needle was horizontal. Similar phenomena were exhibited by both needles, in the various parts of the plate, as on the circular plate first described.

The second of these plates became a magnet of a very singular character, and had *four* poles: one south pole, and three north poles. The south pole was in the middle of the axis, or at the centre of the plate. One north pole was at one end of the polar axis, and two north poles at the other end of the magnet; each about 23° 28′ on each side of the polar axis. The three north poles of this magnet were at the *extreme edge* of the plate; but the two poles of the magnet last described were considerably *within the edge*. This difference in these two magnets, of the same shape and size, may be thus accounted for: In the first, which has but two poles, and those mutually attractive, the poles naturally draw each other towards the centre of

the plate. In the second, with a south pole in the centre, and north poles at the ends, the attractive influence of the centre for either end is counteracted by the opposite attractive influence for the other end; and the north poles are therefore found at the extremities of the plate. These facts seem to throw light on the *oblation of the earth.* In its primitive fluid state, its two magnetic poles of almost inconceivable power, must have had a strong tendency to depress or draw together the parts of the earth near the poles, and thus to shorten the axis. Owing, probably, to the diurnal revolution of the earth, this depression was made round the polar axis, and not round the magnetic. Many other magnets, both plates and bars, were examined; and, in all, the magnetic poles were found *out of* the polar axis, or middle line of the magnet, on the right and left. Where the width of the magnet is small, the angle is small; but where the magnetic fluid was allowed, by the proportions of the plate, to act freely, the angle instinctively taken by the two axes seems to be, in all cases, 23° 28′. It seems, also, a universal law, that the pole is never at the oblong side of a magnet.

The discovery of these laws of the magnetic forces led, necessarily, to their application to terrestrial magnetism. As each artificial magnet had its poles, polar axis, and equator, as well as its magnetic poles, magnetic axis, and magnetic equator; and as all this was true of the earth; as the two magnetic poles in each have an opposite polarity, exerted in each in the some manner; as the two needles, when applied to these various circles in each, obey the same laws, and are affected in the same manner; and as magnetism, or the magnetic power, in each, is one and the same thing, Dr. Sherwood at once concluded that the laws of magnetic influence, in the magnet and in the earth, were one and the same.

This conclusion led to the most important results. He was hence led to see that the magnetic poles of the earth were 23° 28′ from its poles, and of course in the polar circles; that the magnetic and polar axes crossed each other at the same angle of 23° 28′; and that the magnetic and terrestrial meridians of every place crossed each other at angles dependant on the angles of the two axes.

It had been believed by various philosophers, that the magnetic poles have a revolution round the poles of the earth. Dr. Sherwood ascertained, from observations, made at London and Paris more than a century and a half ago, that the line or circle of no variation, was, in two given years, not distant from each other, over those cities. He found also numerous records of its being over other places in its progress westward, at certain other given periods. He also ascertained its exact present position, in various places on the western continent. By a careful comparison of these various results, he ascertained, 1st. That the circle of no variation, and, of course, the magnetic poles, had a regular western progress: and 2dly. That they revolved in a period of 666 years, and of course had an annual motion of $\frac{360}{666}° = 32′\ 26″$.

From the time of Dr. Halley, attempts have been made, without success, to ascertain the true position of the line of no variation. In the latest chart published in Great Britain, by Dr. Barlow, the half of this line in the eastern hemisphere, commencing about 54° south latitude, goes due north till it strikes the southern coast of New Holland, in longitude 128° east; then bending west, leaves the northwest coast of that island in latitude 14° south, longitude 126° east, whence it winds round to Surat, on the west

coast of Hindostan, then winds northeast and southeast over the Himmalaya mountains, through that country, Thibet, and China; thence it winds northeast through the sea of China, and the island of Niphon, and thence nearly north through the sea of Japan, and Chinese Tartary, the sea of Ochotsk, and Siberia; reaching latitude 60° north in about 137° east.

Why the eastern half of the line of no variation was supposed to be thus singularly irregular and circuitous, in its progress from south to north, and particularly near the equator, is not explained; and the supposition appears the more surprising, as the western half is represented in the same chart as pursuing a regular, and not far from the correct, course. The reason of this strange error undoubtedly was this, that, in many places on the magnetic equator, the needle had been found to lie in the geographical meridian; and Dr. Barlow, not aware of this law of magnetic motion, supposed that the line of no variation must then run from east to west.

Dr. Sherwood perceived from the general laws of the magnetic forces, as exemplified in the circular iron plate, that this account of the line of no variation was wholly erroneous, and, by a careful examination of these laws, compared with numerous observations on record, respecting that line, came to the following important conclusions:

That the line of no varietion is *a great circle of the earth;* that it is a magnetic meridian; that it is not, as he at first supposed, *that* magnetic meridian, which is secondary to both equators, and passes through the two magnetic poles, and the two poles of the earth, since many places lying east of that meridian are west of the circle of no variation, or have an easterly variation; but that it is *that* magnetic meridian, which, after cutting the magnetic pole, passes at the distance of 6° 28′ from the pole of the earth.

Of course, after obtaining its exact position on a given day, at any one given place, he was enabled to trace its progress round the earth, and to determine its exact longitude in every latitude. He thus traced its position on the 15th of September, 1837, as follows:

The *arctic semi-circle of no variation*, or that which cuts the arctic magnetic pole, leaving that pole in latitude 66° 32′ north, 93°* 16′ 03″ 04‴ west; then traversed Hudson's bay, west of Mansfield and Southampton islands; entered James's bay, between Lake Muskinau and Abbitibbe river; ran through the Abbitibbe country; crossed the east part of Lake Manitoulin; proceeded a little west of Lake Simcoe; passed about 1° west of Toronto; crossed the west point of Lake Ontario, and the east point of Lake Erie; passed about 31′ west of Fredonia, N. Y.; about 1° east of Pittsburgh; about 2° 22′ west of the city of Washington; about 32′ west of Charlottesville; about 1° 30′ west of Richmond; about 35′ east of Raleigh, N. C., and about 1′ west of Cape Fear. Thence it passed through the Bahama islands; cut the east end of Cuba about 2′ west of the town of Baracoa; cut the west peninsula of St. Domingo, about 17′ west of La Vache; crossed the Caribbean sea; entered South America about 35′ west of Point Gallinas; passed about 10′ west of Maracaibo; intersected the equator in west longitude 69° 09′; passed west of Buenos Ayres; crossed the east cape of Soledad; and cut the antarctic circle in 43° 04′ west.

The *antarctic semi-circle of no variation*, after passing the north pole of the earth, at a distance of 6° 28′, traversed the Northern ocean, within the arctic circle; entered Siberia, at a point about 4° east of Constanti-

*In a few copies it was erroneously printed 96° instead of 93°; and also in 10th line from bottom, 2° instead of 2′.

now; and cut the arctic circle in longitude 110° 11′ 57″ east. Thence it proceeded in a direction west of south; traversed Siberia, Chinese Tartary, and China, passing a little east of Pekin, and west of Nankin and Canton; cut the western ends of Borneo and Java; and thence proceeded through the Indian and Southern oceans, a few degrees west of New Holland, to the antarctic circle; cutting it and the south magnetic pole in 86° 43′ 56″ east longitude; whence it passed by the south pole at the distance of 6° 28′. This position of this semicircle is in one point remarkably confirmed by Yeates; who found it over Canton in 1817—the precise position, where, according to the law of its motion, it must have been at that time.

It is worthy of observation, that Dr. Barlow, in one of his latest remarks respecting the line of no variation and the magnetic equator, has, in a very striking manner, confirmed Dr. Sherwood's theory. By that theory the circle of no variation crosses the equator in *two* points, and the magnetic equator also crosses it in *two* points; and in all *four* of these points of intersection, the needle lies in the geographical meridian. Dr. Barlow, not being aware of the fact, that the needle, every where on the magnetic equator, as well as in the line of no variation, is in the geographical meridian, remarks, that from various observations, there is strong reason to believe that the magnetic equator crosses the terrestrial equator *four* times. Dr. Roget, from a similar mistake, supposes that it crosses it *three* times.

These principles and positions remained to be tested by mathematical demonstration; a task, obviously, of great difficulty. To accomplish it, it was necessary to construct a series of trigonometrical tables, depending on the great principle that the magnetic poles and the circle of no variation have these exact positions, and founded on the angles which the circle of no variation and all the other magnetic meridians make with the geographical meridians in every place on the globe, as well as on those which the magnetic equator makes with the terrestrial equator, and with the geographical meridians. Nor was this all. As all these angles, except that between the two equators, owing to the revolution of the magnetic poles, and to the consequent revolution of the magnetic meridians, are continually changing, it was also necessary to form another series of tables, by which an exact allowance might be made for these changes, in determining the exact position of the various places on the surface of the earth. To do all this, and so to do it that the results should always be attended with mathematical certainty, required very high powers of comprehension, analysis, and construction. To this task Dr. Sherwood applied himself, and formed the requisite tables on these principles. To render these principles of universal practical utility, Dr. Sherwood devised and constructed an instrument which he denominates "THE GEOMETER."

This instrument consists, first, of a horizontal base; second, of an upright dipping needdle. The horizontal base has 12 concentric, moveable, horizontal brass circles, of which the six smaller are marked A, and the six larger B. On the second of the six smaller circles is marked each *degree*, from 1° to 10°, and on the first each 10th degree, from 10° to 90°; on the fourth circle each *minute*, from 1′ to 10′, and on the third each minute from 10′ to 60′; on the sixth circle each *second*, from 1″ to 60″, and on the fifth each second, from 10″ to 60″. Against each degree, minute, and second, is the corresponding *tabular number* of degrees, minutes, and seconds, from the first set of tables; which give the exact angles of the magnetic, with the terres-

trial meridians, in the different latitudes, as well as the angles of the magnetic with the terrestrial latitude, and the distance of the magnetic equator from the terrestrial equator in any longitude. The six larger circles are constructed in the same manner, with this exception, that the corresponding *tabular numbers* of degrees, minutes, and seconds, are from the *second* set of tables, and give the exact difference between the variation of the needle and the variation of the line of no variation from any terrestrial meridian.

When a given number of degrees, minutes, and seconds, is to be looked out in the geometer, for example, 75° 56′ 34″, the number 5° in the second circle is brought under 70° in the first; under this are brought 50′ in the third, 6′ in the fourth, 30″ in the fifth, and 4″ in the sixth. The tabular numbers of degrees, minutes, and seconds, is then added, and the sum is the tabular number corresponding to 75° 56′ 34″. This tabular number, thus found, is used as an element in the given calculation. The six larger circles are used in the same manner. By the first series of circles, the angles of the circle of no variation and of the magnetic meridian with the terrestrial meridian, the variation of the needle, the latitude, and, where the place is less than 12° 56′ from the circle of no variation, the longitude also, are determined. By the second series, the longitude in all cases is ascertained. These are the principles and uses of the geometer. *The question then arises, how shall we ascertain whether the instrument is founded on correct principles?* Common sense answers, "*By trial.* Examples must be taken, and those in sufficient variety to test the correctness or incorrectness of the principles on which the instrument is founded. If the answers are right, they will prove the principles to be correct; if wrong, they will prove them to be incorrect. If the instrument, from the correct dip or the correct variation, will give the true latitude and longitude, it is just what mankind need, and all that they need."

To this test, Dr. Sherwood most readily subjects the geometer. With the correct dip given him, observed at a given time, he works out either or all of the following results: The variation of the needle, the distance of the circle of no variation from the place, and its angle with the meridian, the latitude, and the longitude. With the variation given him, in the same manner, he determines the dip and the other results. With either the dip or variation correctly given, he also determines whether the observed dip or variation, and the observed latitude and longitude, are correctly observed, and *vice versa*. He must know, however, if the dip be given, whether the place of observation is east or west of the circle of no variation, and, if the variation be given, whether it is north or south of the magnetic equator, and near the arctic or antarctic semi circle of no variation, points which would always and of course be known, in the practical use of the geometer. He must also know the time of the observation. By means of one observation of the dip, at any place north of the magnetic equator, and of a second at any place south of the magnetic equator, the times of the observations being given, he determines not only what is the variation at the present time, in any degree, minute, and second on the globe, but what it was at any past period, and what it will be at any future period. He needs but one of these observations for places north of the magnetic equator, and the other for places south of it.

I know that such results will at first appear surprising. Still they flow from mathematical calculations in the use of tables founded on the knowledge of the angles made by certain circles on the surface of the earth, and the

changes made in these angles by the revolution of the magnetic poles, with their apparatus of circles round the poles of the earth. They are therefore no more surprising than similar results which flow from mathematical calculations in the use of tables, founded on the knowledge (as it happens) of *the very same angles* made by certain circles in the heavens, and the changes made in those angles by the revolution of the poles of the equator round the poles of the ecliptic, in 25,868 years. Yet astronomers, by the use of the latter tables, determine, at any moment past, present, or future, the exact positions of the planets, satellites and asteroids; the exact times of all past and all future eclipses of the sun and moon, and of the satellites of Jupiter; the precession of the equinoxes; the exact limits and state of the lunar librations, and the movements and positions, past, present and future, of those comets which revolve in elliptical orbits, and do not break their astronomical engagements.

It may appear not less surprising that a solitary individual, unknown to fame, and living in an obscure village, should, unaided and alone, thus discover laws of magnetic influence, which transform magnetism into a new science, and thence deduce rules and results so important to mankind. Yet parallel cases are not wanting in the history of science and the arts, particularly in the invention of the mariner's compass by some individual even yet unknown; of the telescope by Galileo; of the quadrant by Godfrey; of the steam engine by Watt; of the steamboat by Fulton; of the steam car by Babcock; and of the cotton gin by Whitney; and in the discovery of geometry by Euclid; of algebra and of the nine digits by two unknown Arabs; of fluxions, and attraction, and the laws of the celestial motions, by Newton; of chemistry by Lavoisier; of galvanism by Galvani; and in the new creation of botany by Linnæus; and of geology by Cuvier. These various inventions and sciences came forth from their respective inventors and discoverers complete and perfect, like Minerva, armed cap-a-pie, from the head of Jupiter. The truth is, when any important invention or discovery in science is to be made, one superior mind must survey the unformed elements, as they lie scattered in the chaos; must discover their relations and fitnesses; must reduce them to order and beauty, and then present to the world the finished result. The inventor of the geometer, in the midst of solitude and silence, has for twenty-five years devoted the time and effort, which he could spare from the support of his family, to the discovery of the principles on which it is formed, and to the invention of the instrument. Wisely confining the knowledge of both to his own breast until his work is done, he now comes and makes the result known to Congress and his country.

It is proper, therefore, in answering this question, to examine the actual results of examples wrought out by the geometer. As the working of the sums would swell this document to an unreasonable length, it will be omitted, except in a few of the cases at the close. At the same time, Dr. Sherwood wishes it to be understood, that he invites any member of either House, who is willing to do it, to work out any question on the geometer from the dip or the variation; he giving the rule of the operation. In the following cases the results only are here stated, but the operations are in the possession of Dr. Sherwood, and ready for the most critical examination of any member.

I. Finding the variation.

1. London, 1818: Captain Kater observed the dip to be - - 70° 34′
   Variation, as then observed by him - - - - - 24° 30′ 00″ 00‴ w.
   Variation by the *geometer*, calculated from his dip - - 24° 30′ 1″ 25‴
   Difference - - 1″ 25‴

2. Charleston, S. C.: Captain Mesroun's observation, October 31, 1837.
   Variation, as observed by him - - - - - - 2° 54′ 00″ 00‴
   Variation by the *geometer*, calculated from the dip - - 2° 54′ 43″ 18‴
   Difference - - 43″ 18‴

II. Finding the latitude.

1. Paris, July 3, 1835: Mr. Arago observed the dip - - - 67° 24′
   Latitude, as given by French astronomers - - - - 48° 50′ 00″ 00‴
   Latitude by *geometer*, from Arago's dip - - - - 48° 50′ 23″ 04‴
   Difference - - 23″ 04‴

2. St. Louis, June 15, 1819: Major Long observed the dip - - 70° 30′
   Latitude, as given by Colonel Nicolet - - - - - 38° 37′ 27″ 00‴
   Latitude by *geometer*, from Long's dip - - - - - 38° 37′ 20″ 46‴
   Difference - - 6″ 14‴

3. London, 1818: Kater observed the dip - - - - 70° 34′
   Latitude, as given by British astronomers - - - - 51° 31′ 00″ 00‴
   Latitude by *geometer*, from Kater's dip - - - - 51° 30′ 33″ 23‴
   Difference - - 26″ 37‴

III. Finding the longitude.

1. Greenwich observatory, which is the beginning of longitude.
   Actual longitude - - - - - - - 00° 00′ 00″ 00‴
   Longitude by *geometer*, from maximum variation of the needle - 00° 00′ 00″ 10‴
   Difference - - 10‴

2. New York, April 1: dip observed - - - - - 72° 52′
   Longitude, stated by Bowditch - - - - - - 74° 01′ 15″ 00‴
   Longitude, by *geometer*, from the dip - - - - - 74° 01′ 12″ 34‴
   Difference - - 2″ 26‴

3. Paris, July 3, 1835: Arago's dip - - - - - 67° 24′
   Longitude, as given by French astronomers - - - - 2° 20′ 00″ 00‴
   Longitude by *geometer*, from the dip - - - - - 2° 20′ 11″ 42‴
   Difference - - 11″ 42‴

4. Cape Halket, N. A.; latitude 70° 43′, being 4° 11′ N. of magnetic pole. Observations made by Messrs. Simpson & Deane: variation, 43° 08′ 33″
   Longitude observed by them - - - - - - 152° 14′ 00″ 00‴
   Longitude by *geometer*, from their variation - - - - 152° 13′ 38″ 16‴
   Difference - - 21″ 44‴

5. St. Louis, June 15, 1819, by Major Long - { Dip = 70° 30′ ; Variation = 10° 47′ 38″ 00‴
   July 1, 1835, by Colonel Nicolet: variation - - - - 8° 49′ 08″
   Longitude, as observed by Long - - - - - 90° 06′ 15″ 00‴
   Longitude, as observed by Nicolet - - - - - 90° 19′ 36″ 00‴
   Longitude by unknown engineer, in American Almanac - - 89° 36′ 00″ 00‴
   Greatest difference of the three - - 43′ 36″ 00‴
   Longitude by *geometer*: { From Long's dip - - - - 90° 00′ 43″ 16‴ ; From Long's variation - - - 90° 00′ 00″ 54‴ ; From Nicolet's variation - - - 89° 59′ 59″ 00‴ }
   Greatest difference of the three - - 44″ 16‴

In the following cases, the sums are fully wrought out.

I. To find the variation at St. Louis, north of magnetic equator, and west of line of no variation.

By Major Long, June 15, 1819: Dip = 70° 30′
Lat. = 38° 37′

70° 30′ = 4° 41′ 36″ 00‴ } Tab. A.
7 29 20 }

4 49 25 20
4 49 25 20
30 22 50
30 22 50
7 19 18 = dist. of L. of no var.

10 46 55 38 = variation.
10 47 38 00 = Long's variation.

42″ 22‴ = difference.

90° 00′ 00″ 00‴
88 03 29 00 = long. of magnet pole.

1 56 31 00 = 15′ 38″ 40‴ } Tab. A.
14 36 05 }
8 05
30 22 50

II. Latitude of Valparaiso, south of magnetic equator, and west of line of no variation.

In 1821, Basil Hall observed dip = 38° 46′ S.

38° 46′ = 9° 54′ 29″ 20‴ } Tab. A.
11 59 18 }

10 06 28 58 = 2° 36′ 26″ 40‴ } Tab. A.
1 19 04 02 1 33 52 }
7 18
11 25 33 00 15

Dip = 38° 40′ 00″ 00‴ 2)2 38 08 05
— 5 42 46 30 1 19 04 02

Latitude, 33 03 13 30 2)11 25 33 00
Latitude by Hall 33 01 00 00 5 42 46 30

Difference, 2′ 13″ 30‴

III. Longitude of Valparaiso. Latitude = 33° 03′ 13″ S.

From above 10° 06′ 28″ 58‴
From do. — 2 38 08 05

12 44 47 03
— 1 47 02 56

10 57 34 07

33° 03′ 13″ = 6′ 41″ 26‴ (Tab. C.)
× 16 years.

1 47 02 56

Longitude of L. of no var. On the equator, Angle of mag. mer. and ter. mer., in 33° 03′ 13″ } = 69° 09′ 09″ 53‴
= — 8 37 02 56

60 32 06 57
— 10 57 34 03

71 29 41 00 = longitude.
71 31 00 00 = longitude, as observed by B. Hall.

1′ 19″ difference.

IV. Latitude. Place, west of line of no variation, and south of equator.

1821. By Basil Hall. Dip. = 12° 11′ 30″ *
Angle of equator and mag. equator = 23° 28′ 00″ 00‴
Difference = — 12 11 30 00

— 11 16 30 00

* A captain in the United States navy, in this city, on June 26, 1837, gave the above sum, without naming the place, and demanded the latitude and longitude. Dr. S. wrought out the two answers in my presence; and I therefore certainly know that he did not know the place, nor its latitude or longitude, until after the answers were obtained. The place was Guyaquil.

55 00 00 = 14′ 20″ 26‴. (Tab. A.)
14 20 26

1 09 20 26
1 09 20 26

2 18 40 52 = 4′ 21″ 34‴ } Tab. C.
4 21 41 5
2

Latitude = 2 14 19 11 S. 4 21 41
Hall's latitude 2 13 00 00

Difference = 1 19 11

V. Longitude of the same place.

Latitude 2° 14′ 19″ 11‴ 31′ 17″ 20‴ } Tab. A.
3 39 01
4 57

35 01 18

Long. of L. of no var. on equator	69° 09′ 09″ 53‴	23 28 00 00
	— 35 01 18	— 12 11 30 00
	68 34 08 35	11 16 30 00
	-|- 11 12 08 19	— 4 21 41 above
Longitude	= 79 46 16 54	11 12 08 19
Hall's longitude	= 79 45 00 00	
Difference	= 1 16 54	

VI. Longitude of Charleston, west of line of no variation, October 31, 1837.

Variation observed by Capt. Mesroun and by Lt. Wilkes = 2° 54′ east.
Latitude observed by Capt. M. = 32° 46′ 20″.
80° 20′ 48″ 04‴ = longitude of L. of no variation in latitude 42° 53′ October 31, 1837.
-|-2 38 11 09 = difference of angles of Mag. and Terr. Mer. in 42° 53′ and 32° 46′ 30″ By table A.

82 58 59 13
— 2 54 00 00 = variation.

80 04 59 13
— 6 39 10 = Dist. of L. of no variation from Terr. axis in latitude 32° 46′ 20″ by tab. C.

79 58 31 03 = longitude.
79 57 20 00 = longitude as observed by Mesroun.

1 11 03 = difference.

VII. Longitude of New York. From the variation taken by Professor Renwick at Bergen Point, 4′ 23″ west of the city, and in latitude 40° 39′ 05″ in August, 1837. Taken with great care.

Variation = 5° 39′ 30″.
80° 20′ 03″ 04‴ = longitude of line of no variation, August, 1837.
34 55 03 = difference of angles of mag. and terr. meridian, in latitude 42° 53′ and latitude 40° 39′ 05″ = 11 18 53 09 — 10 35 58 06, by Tab. A.

79 45 08 01
—5 39 30 00 = variation.

74 05 38 01 = longitude of Bergen point.
— 4 22 00 = difference of longitude west of New York.

74 01 16 01 = longitude of New York.
74 01 15 00 = longitude from Bowditch.

1 01 = difference.

VIII. Longitude of New York. From the variation found by Dr. Sherwood, August, 1837. Variation = 5° 44′ 45″ 38‴

80° 20′ 03″ 04‴ = longitude of line of no variation, August, 1837.
— 34 01 36 = difference of angles of mag. and terr. meridian in 42° 53′ and 40° 42′ 30″
= 11 10 53 09 — 10 36 51 33.

79 46 01 28
— 5 44 45 38

74 01 15 50 = longitude.
74 01 15 00 = longitude by Bowditch.

IX. Latitude of Washington, from dip observed by Lieutenant Wilkes, June 26, 1838. Dip. = 71° 13′ 30″.

71 13 30 = 18 30 45 20 } Tab. A.
3 23 22 }
7 49 }

18 34 16 31 = 4° 41′ 36″ 00‴ }
18 34 16 31 8 02 54 } Tab. A.
4 30 }
37 08 33 02 8 }
4 30 32 12

2) 4 50 33 12
32 47 59 50 2 25 16 36 = Variation.

71 13 30 00
—32 47 59 50

38 55 30 10 = Latitude.
38 52 44 00 = Latitude by American Almanac.

2 36 10 = Difference.

X. Longitude of Washington from do.

80 26 17 01 = Long. of line of no variation in 42° 53′ June 26, 1838.
—01 01 59 05 = { Difference of angles of mag. and terr. merid. in 42° 53′ and 38 55 30 10 = 11 10 53 09 — 10 08 54 04.

79 24 17 59
2 25 16 36 = Variation.

76 59 01 23 = Longitude.
77 01 48 00 = Longitude by American Almanac.

2 46 37 = Difference.

The difference is small; but Doctor Sherwood informed Lt. Wilkes that the dip was too large, by a few minutes, before he began the calculations; and that the needle, owing to its shape, threw the magnetic meridian one side of the axis of the needle, and, of course, occasioned the point to descend below the true dip. The most perfect shape of the dipping needle is that of the Rhombus; and the conjugate diameter must be of considerable width in proportion to the transverse.

These are specimens of the *actual results*, wrought out by the geometer, taken from hundreds wrought out by Dr. Sherwood, which I have examined; and from a large number, which I have myself calculated. They are calculated according to *definite rules*, by means of *existing tables*; And any one, who understands arithmetic, can work them out.

With these things in view, I recur to your request, that I will give you my opinion as to the practicability of determining the latitude and longitude, *by land and by sea*, by means of the geometer. The subject, thus proposed, naturally resolves itself into two questions:

I. Can the latitude and longitude be determined by the geometer, *on the land?*

II. Can they be determined *at sea?*

These questions shall be answered, in the order in which they are stated.

1. Can the latitude and longitude be determined by the geometer, *on the land?*

It is a settled axiom, that *uniformly true results, in mathematical reasoning, certainly prove that the premises are true.*

The *premises*, which lead to the actual results by the geometer, are the following:

1. The position of the magnetic poles, 23° 28′ from the poles of the earth, and the consequent angles made by the two equators of 23° 28′.

2. The position of the circle of no variation, as a magnetic meridian cutting the magnetic poles, and passing 6° 28′ from the poles of the earth.

3. The angles made by the magnetic and terrestrial meridians, on the various points of the earth's surface.

4. The revolution of the magnetic poles in the polar circles, with their apparatus of magnetic circles, in 666 years less 36 seconds; equal to 32′ 26″ annually.

5. The correctness of the tables, founded on these various angles.

6. The practicability of taking the dip, *on land*, with accuracy. I say the *dip*, not because the *variation*, when well taken, is not just as good an element of calculation as the *dip*, but because, in taking the former, observers, if not skilful, are liable to tremendous blunders, to which they are not exposed in taking the latter. Of this, were it the proper time and place, I could furnish most pregnant evidence.

These, then, are the *premises*. What, now, are the *results?* We find from hundreds of *examples*, in which the dip has been taken by skilful observers, at given times, as well as the latitude and longitude by means of celestial observations; taken, too, in the frigid, temperate and torrid zones; to the north and to the south of each equator; to the east and to the west of the circle of no variation; on both continents, and on numerous islands; and applied to the tables on the geometer; and in which, by calculations merely *arithmetical*, made according to *established rules*, Dr. Sherwood actually finds the latitude and longitude of each given place, with remarkable precision, and with a nearness of result to the observed latitude, proportioned to the *skill* of the observer, and to the *perfection* of his instruments. But this is not all. The dip may have been taken any number of years back; and yet, by a due allowance for the motion of the circle of no variation, according to the tables, the latitude and longitude are calculated as certainly as if it were taken to-day.

Need I say *more?* Must I demonstrate that the four ground rules of arithmetic are true? If *uniformly true results, in mathematical reasoning*,

prove that the premises are true, then the premises just recited, on which these uniformly true results are founded, *are true*. The latitude and longitude, therefore, can certainly be determined by the geometer *on land*.

II. Can they be determined *at sea*?

The only supposed difficulties are *the influence of the iron, in the ship and cargo, on the needle; and the roll of the ship*.

As to the first difficulty, it is easily obviated. After the cargo is on board, and well secured, if the dip is first taken on shore near the ship, and then on board in the usual place of observations, near the centre of the ship, and *the difference* recorded, all that will be wanting is, *to subtract* it, if the dip on board exceeds the land-dip, and *to add* it, if it falls short, to the dip of the voyage. Dr. Barlow has also devised a method by which the needle is effectually secured from the influence of surrounding iron. To make "assurance doubly sure," both methods may be taken in every case.

2. The roll of the ship.

This presents a question for practical seamen; and they differ in opinion on this point. Some experienced navigators, and among them several officers of the navy at New York, believe that the dipping compass may be swung on a double or quadruple swing, so as always to keep the base on a perfect level. All admit, that the *side-roll* will not affect the needle, and that the *fore-and-aft pitch* presents the only obstacle. It is not for me to decide so important a question. Some facts, however, are known: 1. The dip is actually taken by scientific men at sea. 2. Dr. Barlow, in his attempts to ascertain the true position of the magnetic poles, mentions the fact, that *the dip is very often taken at sea by navigators*. As reasons why he could not place *full reliance* on their observations, he mentions *the customary imperfection of their instruments*, and *the iron in the ship;* but he does not suggest that the roll of the ship had presented any serious difficulty. Had it been found insuperable, or even very great in practice, he could not have failed to mention it. The difficulty arising from the iron in the ship, he has himself remedied; and the plan just suggested furnishes a still more perfect remedy. 3. The observation by the dip is *a single one*, and can be taken at once. 4. The dip can be taken a dozen times in succession, and the *mean* of the observations be found. 5. In a thick sky, the dip is *the only observation that can be taken*, and must be better than none. 6. Human ingenuity has conquered greater difficulties than this.

If these difficulties cannot be fully obviated, still the value of the geometer to the Government and to the people, in settling the boundaries of the Republic, of the various States and Territories, of counties, of towns, and of private estates; in surveys of the public lands; in surveys of the coast; in the construction of maps; in settling disputes, by ascertaining the true variation of the needle in all past periods; and in enabling every man to determine the latitude and longitude of his own dwelling, is too great to admit of calculation.

You need not be reminded, sir, of the erection of a fort, on a commanding point of land on the west side of Lake Champlain, soon after the late war, at the expense of not less, it is said, than half a million of dollars, after a careful survey had been ordered and had been taken by a skilful engineer, and a report had been made, by him, to the then incumbent Secretary of War, that the point was south of the 45th degree of latitude; nor of the fact that the fort was subsequently given up, as on Canadian ground, and the money lost. It would have been saved by the geometer.

In consequence of his great attention to these pursuits, Dr. Sherwood has kept himself in moderate, though not in straitened, circumstances, and is not able to go further without aid. He has commenced the publication of an expensive quarto volume, with numerous plates; but cannot, without unreasonably straitening his family, meet the expenses of that publication, and those necessarily incurred in the earlier stages of the manufacture of the geometer. He wishes, also, to proceed to Europe, to secure his own rights as an inventor, to insure the manufacture of the instrument with a degree of perfection not to be attained in this country, and to take advantage of the suggestions of the ablest mechanicians, as to the best method of guarding it against the effects of the roll of the ship, and of thus rendering it, if possible, as useful on the sea as on the land. If this can be done, I need not say how great a blessing it will prove to "those who go down to the sea in ships," or to those who trust their property on that element. The single fact that, in 1836, upwards of eight hundred American vessels were reported, in the gazettes, as lost at sea, and most of them near the coast, is enough to show the incalculable importance of the subject.

Dr. Sherwood, in his petition, has given to the Government the free use of the geometer, without charge for the patent-right; so that they are at liberty to order the instruments made how and where they please. As to the action of Congress in such cases, I find that a distinction has been wisely taken, heretofore, with regard to patents. Those which are useful merely to the country have been left to individual patronage; while, in numerous instances, those which are directly important to the Government have, in consequence of similar grants of the use of the patent-right, met with direct Governmental aid; in many cases, from several of the departments; in others, by the immediate action of Congress. If that action, when recorded on the annals of science, shall be honorable to the memory of those now on the stage,—to their sense of justice, and to their enlightened liberality,—those who come after us will not be ashamed of the spirit or the deeds of their fathers.

Permit me to add, that if Dr. Sherwood does not receive aid from the action of Congress, the publication of the work just mentioned must be suspended. Owing to a misfortune, to which I can only allude, but which, from a regard to delicacy, I cannot here explain, the pages already printed, *though stereotyped*, must be re-written, and the expense, thus far incurred, must be lost. The action of Congress, also, will be of comparatively little avail to Dr. Sherwood, unless it is *immediate*. If deferred to the next session, he cannot go to Europe; and the consequence will be, that his whole secret will be jeoparded. This very letter, and it cannot now be withheld from publication, will, not unlikely, enable some ingenious man in Europe to discover it. If enabled to embark immediately, he can secure to himself any reward to which such a discovery is entitled; but it should be distinctly remembered, that the reward is offered to the individual who communicates the mode of determining the longitude. I ought to add, that an attempt has already been made, by an Englishman, to ferret out the secret of the discovery, and to possess himself of the TABLES; and that he has actually sent out, by his own confession, all that he could possess himself of, to a man of science in London, in order that he might discover the theory and construct the tables, with the obvious design of anticipating Dr. Sherwood.

Dr. Sherwood is told that a member of the House of Representatives has received a letter from a correspondent in Philadelphia, suggesting that his theory of terrestrial magnetism is the same with that found in Churchman's *Magnetic Atlas*, a work published in that city in 1787, and re-published some years afterwards in London; and that he had borrowed his theory from that work. Dr. Sherwood requests me to state that Churchman's work was first known to him in March last, (being brought to him by a young man, who bought it at auction in New York,) many years after his own theory had been established, and long after he had completed it, together with the various series of tables; that he read three pages only, and then looked through it, having perceived that it was founded on mere assumption, without any proof. I have not myself seen the work; but, to show its true character, and to prove that Dr. Sherwood was not mistaken in his estimate of it, I quote the following extract from the Treatise on Magnetism, (Encyc. Metropolitana, p. 819,) by Dr. Barlow, who had seen and examined the work of Churchman:—"Churchman, in his Magnetic Atlas, has assumed a certain distance and movement of rotation, which give as near approximations as those found above; *but they are dependant upon no previous principle, and are inconsistent with every other magnetic law.*" Dr. Sherwood wishes me to add, that he saw no *tables* in the work of Churchman, except tables of the variation of the needle, in different places on the surface of the earth.

Allow me, sir, to say, in conclusion, at Dr. Sherwood's request, as well as on my own behalf, that neither of us can ever forget the deep interest manifested by yourself, from the beginning, on this subject, as the enlightened friend of science, and the true patriot; nor the uniform kindness and gentlemanly courtesy which you have shown to us both; and while we also cherish a grateful remembrance of the like feelings and conduct, exhibited by very many members of both Houses of Congress, as well as by those in the Executive department, permit me to assure you, without an apology for the length of this communication, that I am,

My dear sir, with very high esteem and regard,
Your friend and obedient servant,
S. E. DWIGHT.

Hon. NATHANIEL P. TALLMADGE,
Of the Senate.

WASHINGTON CITY, *June* 21, 1838.

SIR: Knowing that, in common with all patrons of scientific research, you feel great interest in all discoveries that promise to enlarge the boundaries of human knowledge, and particularly on a subject so interesting to the whole world, as the one which forms the object of Dr. Sherwood's theory of magnetism, I venture respectfully to submit to you, in the accompanying statements, the substance of what, after much investigation, I have been enabled to arrive at, in relation to the principles of this most novel and interesting theory.

Feeling my own inability to push beyond certain very narrow limits any very close research on this subject, I have been induced to submit this

statement to you, from a hope that it may lead a mind like yours to further investigation of a theory, which, under any aspect that it may be viewed, well merits the most serious consideration.

Very respectfully,

Your obedient servant,

JAMES FERGUSON.

To Hon. N. P. TALLMADGE,
Senate United States.

The following is respectfully submitted to the Hon. N. P. Tallmadge:

Dr. Sherwood's theory of magnetism, as applicable to the discovery of the latitude and longitude of places on the globe, as far as I have been able to understand it.

This theory proceeds on the principle, that the longitude of the north magnetic pole has been determined to be 93° 16′ 03″ 04‴ on the 15th September, 1837, and its uniform latitude to be 66° 32′: That this magnetic pole performs a revolution around the terrestrial pole in 666 years, less 36″: That this time was calculated from actual observation of the situation of the line of no variation, and consequently of the magnetic pole in different and distant periods of time: That the annual rate of motion of the pole, and line of no variation, was determined by dividing 360° by 666, which gave 32′ 26″ for the annual rate of motion: That it was determined, by a series of experiments, that the *magnetic axis* of a *magnetized* body was *always* at an *angle with* the *axis of the body* itself; and that the angle of the magnetic axis of the earth was at an angle with its terrestrial axis of 23° 28′: and that consequently the magnetic equator of the earth was at an angle with its terrestrial equator of 23° 28′: That the magnetic axis, and consequently the magnetic meridian, being always at the same angles with the terrestrial meridians, and the motion of the needle bearing a certain proportion to the motion of the poles and magnetic meridian, a table was constructed on these principles, which gave the exact angles of the magnetic with the terrestrial meridians in the different latitudes, and the exact difference in degrees and the parts of degrees between the variation of the needle and the variation of the line of no variation from any meridian; and thus the longitude of places was determined. The same table gives the angles of the magnetic with the terrestrial latitude, and the distance of the magnetic equator from the terrestrial equator in any longitude. Such is the theory.

The value of the principles embraced in this theory depends, like all others in every branch of practical philosophy, upon the character of the facts from which they are drawn; but this much may be safely affirmed, that if the facts be such as to warrant the principles he has drawn from them, then the application of these principles to the discovery of longitude must, upon the soundest geometrical reasoning, be of mathematical certainty; for instance, if Dr. Sherwood has been able, by deductions from incontrovertible data, to construct a table, as he professes to have don which gives the exact angles of the magnetic with the terrestrial meridian

in the different latitudes, and the exact difference in degrees and the parts of degrees between the variation of the needle, and the variation of the line of no variation from any meridian, then the determination of the longitude must follow as certainly, as the conclusion from any demonstrative truth whatever.

JAMES FERGUSON.

WASHINGTON, *June* 27, 1838.

SIR: We have examined the instrument exhibited by you, which you call a "Geometer," for ascertaining the true dip of the magnetic needle, thence the variation of the compass, the latitude and longitude of the place of observation.

In the absence of any practical knowledge or experiment of the instrument, we can express an opinion only as derived from the explanation of its principles given us, and the examples worked out and presented us by yourself, from which we think that, whenever the geometer can be placed *free* from motion, it will give true results; but that, owing to the constant motion of a ship at sea, the vibration of the needle will necessarily be so great, that the accuracy of the results cannot be safely relied upon. This difficulty or objection does not, of course, apply to experiments made on shore, or on board ship, when at anchor, with very little or no motion, and we shall be glad to see the instrument carried to perfection, and a series of experiments made with it, to test its accuracy and usefulness.

Very respectfully,
Your obedient servants,

DAN. T. PATTERSON, *U. S N.*
J. H. AULICK, *U. S. N.*

Dr. H. H. SHERWOOD,
Washington City.

WASHINGTON, *June* 26, 1838.

SIR: At the request of Doctor Sherwood, I address a line to you on the subject of his discovery in magnetism, and its application, by means of the instrument which he calls the *geometer*, for ascertaining the latitude and longitude, by the aid of the dipping needle. It has not been in my power to investigate the subject in that thorough manner which its great importance demands; but I have seen enough to justify me in concluding that the principle upon which he proceeds is correct, or, in other words, that his discovery of the law which governs the revolution of the magnetic poles is real. From this admission, it follows that I, also, admit the correctness of the principle upon which the geometer is constructed. The verifications of this, exhibited by Doctor Sherwood, and examined by me with some care, are too numerous, various, and positive, to leave any doubt on this point.

The application of the instrument to its intended purpose, on land, appears to me to have been sufficiently demonstrated; whether it can be advantageously applied on board a vessel, at sea, is a practical question, which I cannot pretend to decide. I learn, however, that some of the officers of

the navy, most competent to determine this point, believe that observations, sufficiently accurate to render the instrument a valuable acquisition in navigation, may be made on board of a vessel under way. These opinions have gone far towards removing my doubts upon this point, as it is one upon which I have no experimental knowledge.

To me it appears difficult to overrate the importance of the discovery; and it is certainly one which merits the most thorough practical investigation.

I have the honor to be,
Very respectfully,
Your obedient servant,
THOMAS P. JONES.

The Hon. N. P. TALLMADGE,
Of the Committee of the Senate on Naval Affairs.